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⑤④露光装置

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明　　細　　書

発明の名称　露光装置

特許請求の範囲

1．第1のパターンが設けられ、かつ、その上に感光剤層が形成された基板における上記第1のパターンをレンズ系を介して検出し、上記感光剤層を感光すべき第2のパターンと上記第1のパターンとの位置合せを行ない、上記感光剤を上記第2のパターンでもつて感光させる露光装置において、上記レンズ系と上記基板との間に光学的に透明な液体層を介在させ、かつ、上記レンズ系が光学的に平行で透明な板状部材を介して上記液体層と接する如く構成してなることを特徴とする露光装置。

発明の詳細な説明

本発明は、半導体集積回路等の製造工程で用いられる露光装置の改良に関するものである。

第1の微細パターンの描かれた半導体基板上のパターンを観察して、相対的な位置合わせを行なつた後、第2のパターンを投影する半導体露光装置において、観察すべき第1のパターンは凹凸を有する段差状の形状を成しており、その段差状のパターンの上に感光剤であるホトレジスト層が形成されている。しかし、このホトレジスト層は、観察すべき第1のパターンの凹凸に従つて凹凸が生じてその塗布厚さが均一でなくなり、観察光を照射すると半導体基板からの反射光と半導体基板への入射光とが相互に干渉して、レジスト層の膜厚差による干渉縞が生じ、観察光学上の障害となつている。

したがつて、本発明の目的は、第1のパターンを有する基板上に形成されたホトレジスト層の膜厚の差によつて生じる干渉縞の影響を低減して第1のパターンの位置を高精度に検出し、第2のパターンを正確に露光する露光装置を提供することにある。

上記目的を達成するために本発明においては、第1のパターンが設けられ、かつ、その上に感光剤層が形成された基板における第1のパターンをレンズ系を介して検出し、感光剤層を感光すべき

系を構成するフロントレンズである。ガラス板１３と液体層１２との接する境界面でも屈折率の差から干渉縞の発生もあり得るが、液体層１２の厚さを適当に規定することにより、その境界面を縮小投影レンズ４の焦点深度外の領域に設定することは容易であるので、ガラス板１３の屈折率は任意にすることが可能である。

従つて、ガラス板１３は縮小投影レンズ４に最適な屈折率を有するものが使用できる。なお、ガラス板１３と液体層１２とを介した場合の縮小投影レンズ４の焦点位置合わせは、移動台９を光軸方向に動かして制御することによつて避せられる。

上述のように本発明は、主にホトレジスト層６の表面に生じる干渉縞の発生を低減させるという効果が得られるものであるが、付随的に以下の利点も得られるものである。

用いる液体層１２を清浄化した、温度制御した状態のものを用いることにより、現在、半導体プロセス上問題となつているウエーハ５上への塵埃の付着や、外周囲の温度変化の影響を極わめて小さくすることが容易になり、微細化パターンの形成を要求される半導体プロセスにおける歩留りの向上が図れる。

上述した実施例において使用したホトレジストはShipley 社のポジテイブホトレジスト AZ1350J であり、このホトレジストを厚さ約１μmで塗布してホトレジスト層６を形成した。このホトレジスト層６の光の屈折率は約1.65である。また、液体層１２は光の屈折率が約1.33の水、光の屈折率が約1.50のベンゼンの２種類を使用した。そして、ガラス板１３は通常用いられている光学ガラスであり、その厚さは２.３㎜のものを用いた。この光学ガラスの光の屈折率は約1.5である。

なお、本発明は、干渉縞等の外乱を防止できるため高分解能で、かつ、高精度な微細パターンの検査装置として応用することも可能である。

また、半導体露光装置における主たる投影光学系とは別に、第２のレンズ光学系を用いて、ウエーハ上のパターンの位置を検出する方式を取る半導体露光装置において、第２のレンズ光学系のウエーハに対面した対物レンズの下端に、本発明を応用することにより、ウエーハ上に塗布されたホトレジストの表面の凹凸に起因する干渉縞による外乱を防いで、検出精度を向上させることができる。

以上説明したごとく、半導体基板に塗布されたホトレジスト層の膜厚のムラによつて生じる干渉縞によるウエーハ上のパターンの位置を誤検出することを防ぐため、ホトレジスト層の屈折率に近い屈折率の液体層でホトレジスト層の表面をおおい、かつ、縮小投影レンズの下端に設けた光学的に平行で透明なガラス板を液体層に接触させた状態で駆動する露光装置の構成とすることにより、高精度なパターンの重ね合わせが行なえるようになる。

また、清浄化された液体層でホトレジスト層の表面をおおうため、ウエーハ上への防塵対策が容易になる。さらには、熱容量の大きい液体層を用いることが可能であるため、外部の温度変化に対するウエーハの変形等も容易に防ぐことが可能となるなどの付随的な効果も得られる。

図面の簡単な説明

第１図は本発明による露光装置の概略構成図である。

１…光源、２…コンデンサレンズ、３…レテイクル、４…縮小投影レンズ、５…基板（ウエーハ）、６…ホトレジスト層、７…第１のパターン、８…位置検出光学系、９…移動台、１０…膜厚差（凹凸）、１１…ハーフミラー、１２…液体層、１３…ガラス板、１４…シール板、１５…フロントレンズ。

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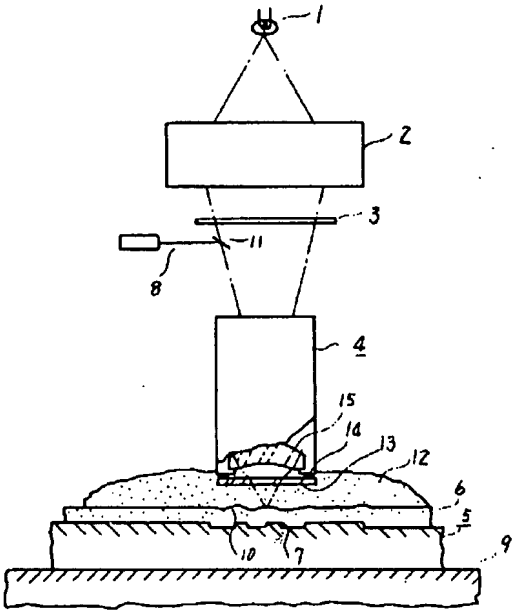
第　１　図



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Specification

Title of the Invention: Exposure Apparatus

Scope of Patent Claim

1. An exposure apparatus that detects via a lens system a first pattern of a substrate in which a photosensitive material layer is formed on the first pattern and that performs alignment of a second pattern, which is to expose the photosensitive material layer, with the first pattern and that causes exposure of the photosensitive material using the second pattern; characterized in that it is configured by interposing an optically transparent liquid layer between the lens system and the substrate and bringing the lens system into contact with the liquid layer via an optically parallel and transparent plate-shaped member.

Detailed Explanation of the Invention

The present invention relates to improvements to an exposure apparatus used in manufacturing processes such as those for semiconductor integrated circuits, etc.

In a semiconductor exposure apparatus that, after observation of the pattern on the semiconductor substrate, on which a first detailed pattern has been drawn, and relative alignment are performed, projects a second pattern, the first pattern to be observed has a bump-shaped form that has irregularity, and a photoresist layer, which is a photosensitive material, is formed on that bump-shaped pattern. However, this photoresist layer is such that irregularity is produced according to the irregularity of the first pattern to be observed, and the coating thickness thereof becomes no longer uniform, and when observation light is irradiated, the reflected light from the semiconductor substrate and the incident light going to the semiconductor substrate interfere with each other, interference fringes resulting from the differences in film thickness of the resist layer are produced, and this leads to malfunctions in terms of observation optics.

Therefore, the purpose of the present invention is to provide an exposure apparatus that detects the position of the first pattern with high accuracy by reducing the effect of interference fringes produced due to the differences in

film thickness of the photoresist layer formed on a substrate that has a first pattern and that exposes the second pattern correctly.

In order to achieve the aforementioned purpose, the present invention is an exposure apparatus that detects via a lens system a first pattern of a substrate in which a photosensitive material layer is formed on the first pattern and that performs alignment of a second pattern, which is to expose the photosensitive material layer, with the first pattern and that causes exposure of the photosensitive material layer using the second pattern; characterized in that it is configured by interposing an optically transparent liquid layer between the lens system and the substrate and bringing the lens system into contact with the liquid layer via an optically parallel and transparent plate-shaped member.

Through the present characteristic configuration of the present invention, it is possible to restrict the effects of interference fringes attributable to irregularity in the film thickness of the photoresist layer, so it is possible to correctly detect the position of the pattern on the substrate. As a result, it has become possible to provide an exposure apparatus capable of high accuracy exposure.

The present invention will be explained in detail below while referring to all of the embodiments.

FIG. 1 shows the basic configuration of an exposure apparatus resulting from the present invention. The exposure apparatus comprises a light source 1, a condenser lens 2, a reticle 3 on which an enlarged pattern has been drawn, and a reduction projection lens 4, and it forms the desired pattern on a wafer 5 by projecting the pattern drawn on the reticle 3 to a photoresist layer, which is a photosensitive material coated onto the semiconductor wafer 5 that is the substrate.

In general, for semiconductor devices, it is necessary to perform high accuracy alignment of various circuit patterns several times and perform exposures superimposingly. To perform the exposures superimposeingly, the position of a first pattern 7 formed in advance is detected by detection optical systems 8, 11, a movable base 9 on which the wafer 5 has been placed is driven, positioning of the wafer 5 to the desired position is performed, and exposure is performed in the correct alignment with the second pattern formed on the reticle 3. Normally, the first pattern 7 discussed above forms an irregular bump shape, so the surface shape of the photoresist layer 6 for exposing the second pattern of the reticle 3 also produces irregularity (film thickness differences) as shown in the irregularity of the first pattern 7.

The detection optical systems 8, 11 of the position of the first pattern 7 detect the first pattern 7 via a reduction projection lens 4. In general, reduction projection lenses with high resolving power used in exposure apparatuses are designed for a single wavelength of light, so the light used in the detection optical systems 8, 11 also uses a single wavelength of light. When a single wavelength of light is used to detect the first pattern 7 via a transparent photoresist layer 6, the reflected light from the surface of the wafer 5 and the incident light going to the wafer 5 interfere with each other, interference fringes that correspond to the difference of film thickness of the photoresist layer 6 are produced at the interface at which medium with different refractive indices come into contact, such as the photoresist layer and the air layer. These interference fringes become shaded line shapes, so it is difficult to distinguish them from the contours of the first pattern 7, which becomes a cause of detection error, and, as a result, this becomes a factor that causes deterioration of alignment accuracy. Particularly in the case where film thickness differences (irregularity) 10 of a photoresist layer 6 with a shape that is completely similar to the shape of the first pattern 7 are obtained, interference fringes are used to detect the position of the first pattern 7, and it is also possible to infer the pattern position from this, but, in actuality, it is not possible to obtain the film thickness differences (irregularity) 10 of a photoresist layer 6 with a shape similar to a first pattern 7 that has bumps.

Therefore, in the present invention, the occurrence of interference fringes resulting from film thickness differences (irregularity) 10 of the photoresist layer 6 discussed above is reduced to improve detection accuracy of the first pattern 7, so it is configured in the following way. In order to reduce the occurrence of interference fringes, the difference in the refractive indices at the interface where the surface of the photoresist layer 6 and the liquid layer 12 come into contact becomes smaller due to the fact that the surface of the photoresist layer 6 is covered by a liquid layer 12 that has a refractive index that is nearly equal to the refractive index of the photoresist layer 6, and the occurrence of interference fringes at the surface of the photoresist layer 6 can be reduced. However, in a static status, the surface of the liquid layer 12 becomes a free surface, so it is flat, but in the case of use as an exposure apparatus, the movable base 9 on which the wafer 5 has been placed steps and repeats at high speed, so a problem occurs in that the surface of the liquid layer 12 undulates. Therefore, in order to always keep the surface of the liquid layer 12 flat with respect to the reduction projection lens 4, in the present invention, an optically parallel and transparent glass plate 13 is provided at the lower end of the reduction projection lens 4. The glass plate 13 maintains a status in which it is always in contact with the liquid layer 12. The reduction projection lens 4 and the glass plate 13 are partitioned by a seal material 14. Here, the lens 15 is a front lens that constitutes the lens system of the reduction projection lens 4. Even at the interface at which the glass plate 13 and the liquid surface 12 come into contact, generation of interference

fringes from the difference in the refractive indices is possible, but by appropriately specifying the thickness of the liquid layer 12, it becomes easy to set up that interface in a region outside the depth of focus of the reduction projection lens 4, so the refractive index of the glass plate 13 can be set as desired.

Therefore, it is possible to use a glass plate 13 that has a refractive index that is most appropriate to the reduction projection lens 4. Note that focusing procedure of the reduction projection lens 4 in the case in which the glass plate 13 and the liquid layer 12 are passed through is achieved by performing control by moving the movable base 9 in the optical axis direction.

In the aforementioned way, the present invention is able to achieve the effect of reducing the generation of interference fringes produced mainly at the surface of the photoresist layer 6, and it is such that the following related benefits can also be obtained.

By using the liquid layer 12 which has been cleaned and temperature controlled, it is easy to make the effects of adherence of dust and dirt onto the wafer 5 and of temperature changes at the periphery, which are problems in terms of semiconductor processes, extremely small, and yield improvement can be pursued in semiconductor processes in which the formation of fine patterns is required.

The photoresist used in the embodiment discussed above is positive photoresist AZ1350J made by Shipley, and the photoresist layer 6 was formed by coating a thickness of approximately 1 μm of this photoresist layer. The refractive index of this photoresist layer 6 for the light is approximately 1 .65. In addition, for the liquid layer 12, two types, which are water with a refractive index of light of approximately 1 .33 and benzene with the refractive index of light of approximately 1.50, were used. In addition, the glass plate 13 is a commonly used optical glass, and one with a thickness of approximately 2 .3 mm was used. The refractive index for the light of this optical glass is approximately 1.5.

Note that present invention is able to prevent disturbance such as interference fringes, so it can also be applied as a high resolution, high accuracy fine pattern inspection apparatus.

Also, in semiconductor exposure apparatuses that adopt a system of detecting the position of the pattern on the wafer using a second lens optical system in addition to the main projection optical system in the semiconductor exposure apparatus, it is possible to prevent disturbance resulting from interference fringes attributable to the irregularity of the surface of the photoresist coated onto the wafer and to improve detection accuracy by applying the present invention to the lower end of the objective lens of the second lens optical system that opposes the wafer.

As explained above, to prevent erroneously detecting of the position of the pattern on the wafer resulting from interference fringes generated by irregularities in the film thickness of the photoresist layer coated onto the semiconductor substrate, high accuracy pattern superposition can be performed by using a configuration of an exposure apparatus that performs driving in a status in which the surface of the photoresist layer is covered using a liquid layer with a refractive index near the refractive index of the photoresist layer and an optically parallel and transparent glass plate provided on the lower end of the reduction projection lens is brought into contact with the liquid layer.

In addition, since the surface of the photoresist layer is covered by a cleaned liquid layer, it becomes easy to perform dustproofing countermeasures on the wafer. Moreover, since it is possible to use a liquid layer with a high thermal capacity, related effects such as it also being possible to easily prevent deformation etc. of the wafer with respect to external temperature changes can be achieved.

Brief Explanation of the Drawings

FIG. 1 is a schematic block diagram of an exposure apparatus resulting from the present invention.

1 light source
2 condenser lens
3 reticle
4 reduction projection lens
5 substrate (wafer)
6 photoresist layer
7 first pattern
8 position detection optical system
9 movable base
10 film thickness difference (irregularity)
11 half mirror
12 liquid layer
13 glass plate
14 seal plate
15 front lens

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